

AUTOMATED EVALUATION OF STRAIN FIELDS BY THE COORDINATE-GRID METHOD

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We develop an automated coordinate-grid method (CGM) aimed at the evaluation of surface displacements and strains. Points of marking of the surface are used as bases. The principles of application of the CGM are described in detail. By using the proposed method, we find the elastoplastic strains in the material. The possibilities of the CGM are experimentally verified and its applicability to the evaluation of strains and displacements is demonstrated.

Keywords: digital photographic image, vector of displacement, strain, stress.

There exist numerous approaches to the determination of local strains in structural elements among which one can mention the well-known coordinate-grid method [1–6]. The application of digital technologies makes it possible to perform mathematical processing of the obtained photographic images and substantially decrease the laboriousness of data processing [5, 6]. To increase the accuracy of measurements, it is customary to use high-resolution optical microscopes and photocameras [7]. However, there exist methodical difficulties connected with the identification of points of the coordination grid, taking into account the gradient of illumination of the specimen surface, and other specific features of getting and processing the images.

In what follows, we study the strains formed on the surface of a steel specimen under static loading and determine the vectors of displacements of mesovolumes of the material of the specimen.

Experimental Procedure

The discrete monitoring of the process of deformation of the specimen surface was performed by recording and processing digital photographic images of a preliminarily plotted coordinate grid. We used flat specimens 200 mm in length, 25 mm in width, and 5 mm in thickness. On the lateral side of the specimens, we made concentrators 2 mm in depth and grew fatigue cracks to analyze plastic zones for different values of the stress intensity factors. The specimens were loaded in an STM-100 universal servohydraulic tensile-testing machine.

The specimens were first marked by the method of electrochemical etching by making a grid of dimples. The original of the grid was printed on a transparent film and put on a polished surface of the specimen (with roughness not higher than $R_a = 0.63$) covered with a photoresist lacquer. The specimen surface was irradiated with the light of a mercury-quartz lamp and, as a result, the image of the dividing grid was obtained on the photosensitive protective lacquer coating [8]. The grid of points was developed in a bath with a weak NaOH solution, and the specimen was washed in distilled water and dried. Then it was dipped in a sodium-chloride–sodium-phosphate mixture for electrochemical etching of the unprotected regions. The dimples of the dividing grid were obtained with a depth of 2–3 μm , a diameter of 0.02 mm, and steps of up to 0.1 mm.

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